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ON THE POINTS OF CONTACT BETWEEN MAGNETISM AND LIGHT.

OF all physical investigations, perhaps the most important at the present day is the discovery of definite relationships between the phenomena of electricity and magnetism and those of light. Our readers are doubtless aware of the critical theoretical issues which depend upon the precise determination of this relationship. When corresponding electro-static and electro-magnetic phenomena are numerically compared, it is well known that the latter are larger than the former, and the number of electro-static units in one electro-magnetic unit is found to vary inversely as the magnitude of the unit of length, and directly as the magnitude of the unit of time adopted. Hence, the ratio of the two units is expressed by a length divided by a time; but space divided by time expresses velocity, and the conclusion is therefore obvious that the relationship between these two sets of phenomena is really a definite velocity—a natural quantity, in fact, the magnitude of which can be determined. Now, the measurement of this quantity is, as Prof. Clerk Maxwell has said, one of the most important researches in electricity. We are not, however, left in doubt as to the value of this ratio, for it has been measured by Weber and Kohlrausch, Thomson and Maxwell, and the extremely important fact has thus been revealed that the ratio of the two sets of units is a quantity of the same order of magnitude as the velocity of light. Neither of these constants has yet been determined with such accuracy as to enable us to say that one is greater or less than the other. Thus, the velocity of light, determined by Fizeau, is 314,000,000 metres per second, and as determined by Foucault, 298,360,000; the ratio of the electric units determined by Weber is 310,740,000, and by Maxwell, 288,000,000 metres per second. Thus, we have strong reasons for believing "that light is an electro-magnetic phenomenon,"* and therefore it is more than probable, as Faraday long since suggested, that if a material medium fills space, it has other functions besides the conveyance of luminous and calorific radiations. In fine, the ether, which the undulatory hypothesis of light compels us to assume, is the electro-magnetic as well as the luminiferous medium—for the properties of the two media are identical—and thus a very weighty confirmation has been obtained of the real existence of this universally-diffused and transcendently-subtle form of matter.

The meaning of the first sentence in this article will now be more apparent, and the question we have to ask ourselves is, what points of contact have as yet been experimentally found between electricity and magnetism on the one hand, and light on the other; and what is the nature of such relationships, if any?

Passing over the doubtful experiments of Morrichini, Christie, and Somerville, on the influence of the solar rays on needles and magnets, we come to Faraday's great discovery, termed by him "the magnetisation of light," but which would be more correctly expressed as the effect of magnetic force in turning the plane of polarisation of light transmitted through diamagnetic substances. This discovery Faraday made in September, 1845, and it forms the 19th series of his "Experimental Researches."

Those famous words spoken by Macbeth, seem specially applicable to Faraday, and his spirit of courageous investigation:—

> "'Tis much he dares;
> And to that dauntless temper of his mind,
> He hath a wisdom that doth guide his valour
> To act in safety."

He tells us he was led to the discovery by the conviction "that all the forces of nature are mutually dependent, having one common origin." Just as the intrepid explorer of some unknown region is guided by a prevailing idea, so Faraday, through all his work, was fascinated by this dominant impression, that the energies in Nature were one in essence, though different in manifestation. Not disheartened by repeated failures, he at last transmitted a ray of plane-polarised light through a transparent diamagnetic medium (the first substance tried being heavy glass, which he had long previously made for his optical experiments), and as the light emerged from the substance, the plane of polarisation was observed by noting the position of the analyser when it cuts off the ray. A powerful magnetic force was then made to act, so that the lines of force within the substance coincided with the direction of the ray. Faraday thus found that the effect of magnetic force was to turn the plane of polarisation through a small angle, round the direction of the ray as an axis. The direction in which the ray has thus been turned is the same as the direction of the positive current in the electro-magnet. This is the case for diamagnetic media; for certain salts of iron the direction of

* Maxwell's "Electricity a Magnetism," vol. ii., chap. 20.

rotation has been found to be the reverse of the foregoing.

Now there are certain substances, such as solution of sugar, turpentine, &c., which independently of magnetic force rotate the plane of polarisation as the ray passes through the substance. There is this radical difference, however, between such natural rotation and that induced by magnetic action—viz., in the former case the direction of rotation is reversed when the direction of the ray is reversed, and in the latter case the direction of rotation is exactly the same whichever way the ray passes along the substance, the direction of rotation only being reversed by reversing the magnetic poles. If it were possible to reflect the ray to and fro along the diamagnetic body, the amount of rotation would therefore be increased in direct proportion to the number of times the ray traversed the body.

The physical explanation of the phenomenon discovered by Faraday is given by Professor Clerk Maxwell in his wonderful treatise on "Electricity and Magnetism." Our space will only allow us to make the following extract, in which Prof. Maxwell expresses the phenomenon of rotation, and which is independent of any theory of light. "A plane-polarised ray falls on the medium. This is equivalent to two circularly-polarised rays, one right-handed, the other left-handed, as regards the observer. After passing through the medium the ray is still plane-polarised, but the plane of polarisation is turned, say, to the right (as regards the observer). Hence, of the two circularly-polarised rays, that which is right-handed must have had its phase accelerated with respect to the other during its passage through the medium. In other words, the right-handed ray has performed a greater number of vibrations, and therefore has a smaller wave-length within the medium, than the left-handed ray, which has the same periodic time." In fact, the index of refraction of the glass for one of the circularly-polarised rays is altered by the act of magnetisation.

It is clear the relationship between light and magnetism discovered by Faraday is a molecular phenomenon; the heavy glass is a diamagnetic body, and tends to place itself across the magnetic field, but being constrained to occupy an axial position, its molecules are thrown into a state of strain which is revealed by polarised light.

Prof. George Forbes has shown* that the same effect as that discovered by Faraday might be produced without the aid of magnetism, if the rod of heavy glass were rotated round the axis of the ray of light with great velocity. The rotation of the plane of polarisation would be the angle rotated whilst the ray traverses the glass rod. This is on the assumption that the ether within the rod is likewise rotated. But to produce by rotation an effect corresponding to the magnetic effect, the glass rod would have to be rotated ten million times a second, and this is beyond the range of experiment. Further, Prof. Forbes points out that supposing the molecules of the glass and the accompanying ether to be rotated round the lines of magnetic force, in the direction of the positive current producing the given magnetic field, then the phenomenon discovered by Faraday would be explained. So soon as the electro-magnet is demagnetised, the rotation of the molecules ceases. It seems, then, Prof. Forbes thinks, there is a friction among the molecules tending to stop the rotation, and if this be so, it follows that when the electro-magnet is excited, the rod of glass will have a tendency to turn bodily round an axis through its centre of gravity, and parallel to the lines of force, and if the rod be free to move, such a rotation ought to be observed. Prof. G. Forbes has put his ingenious hypothesis to the test; and though his investigation is as yet incomplete, the results of his experiments hitherto have shown that there is an effect of the kind anticipated. The nature of the deflection was found to depend on the polarity of the magnet, and by timing the reversals of the current a considerable amplitude of rotation was obtained.

Prof. Maxwell has added a valuable note to Prof. Forbes' paper, pointing out, as he had already done in his work on Electricity, "that there can be no doubt a rotation of some kind is going on in a diamagnetic medium under magnetic force, and this may be of the molecules, of the glass, of the ether, or what not, and this probably goes on in all media, whether transparent or not." Prof. Maxwell, however, objects to the assumption that this rotation is stopped by inter-molecular friction as soon as the magnetic force is removed, inasmuch as it has never been shown that a magnet must necessarily lose its magnetism. "Hence we must admit," Professor Maxwell adds, "that the molecular rotation is not accompanied by friction, but that it is set up by electro-motive force, and exerts electro-motive force when it is stopped, like a rotating body having inertia." Prof. Maxwell then indicates how the points suggested by Prof. Forbes may be investigated experimentally.

(To be concluded in our next.)

* Proc. Royal Soc. Ed., vol. ix., No. 94, p. 83

INFLUENCE OF TEMPERATURE ON THE GALVANIC CONDUCTIVITY OF TELLURIUM.

CONDUCTORS of the galvanic current have been divided into two classes, those which do and those which do not undergo a chemical change in the process of conduction. The latter (*e.g.*, metals) have, in general, their conductivity diminished by rise of temperature. The former (*e.g.*, all decomposable liquids) have it increased.

Tellurium and selenium form a remarkable exception, in that their conductivity is, at least within certain limits, increased by heating. The researches of Dr. Siemens on selenium have formerly been described in these columns. The behaviour of tellurium has been experimentally investigated by M. Franz Exner (*Pogg. Ann.*), with results which we shall here briefly record.

Three bars of tellurium were prepared, pulverised tellurium being fused in glass tubes, then allowed to cool in air. (In some cases the tubes cracked; tellurium, like bismuth, expands in passing into the solid state.) Bar I. broke before its dimensions were determined. Bar II. was 54mm. in length, and 2·6mm. in diameter. Bar III. was 153mm. in length, and 3·73mm. in diameter. The heating was done in an air-bath, and the resistance was measured at intervals with a Siemens universal galvanometer. The phenomena were as follows:—

Bar I. was heated from the temperature of the room to about 200°C, then slowly cooled. There was an increase of the resistance up to 90°, then a gradual decrease to 200°. But in cooling, the turning point at 90° was not perceptible; the resistances increased from 200° continuously to the room-temperature; and so strongly, that the resistance at the end of the experiment was six times as great as that at the same temperature at the beginning of the experiment.

The same bar was again heated from 22° to 200°. There was now no turning point; the resistance decreased continuously on to the highest temperature, and increased continously throughout in the cooling. At the end, however, the resistance was less than at the beginning of the experiment. In a third experiment, the turning point was again wanting, but at the end the resistance was again increased; and in a fourth experiment the same was again diminished. On the other hand, at the maximum temperature of 200°, the resistance was in all four cases pretty much the same.

The second bar also gave a turning point in the first experiment, but this was considerably higher, viz., at 140°. In cooling, it showed a regular increase of the resistance, which finally was four times as great as at the beginning, at the same temperature. Several repetitions showed a behaviour not essentially different from that of Bar I.

With Bar III. five series of experiments were made, and with quite similar results. With the first heating there was a turning point, which did not appear with after heatings. At the maximum temperature, the resistance was pretty constant, while the resistances at the beginning and end of the experiments were very irregular.

Two questions call for answer:—Why has tellurium, being a metal, a less resistance at a higher temperature than at a lower? and why has this resistance not a constant value for each temperature?

It soon appeared that the final resistance depended on the velocity of cooling. The duration of the heating to 200°, did not affect either the value of the resistance at 200°, or that obtained at the end of the cooling. The duration of cooling, however, determined the final resistance; which was less the more rapid the cooling. The molecular state after cooling seems to depend essentially on the duration of cooling.

"Considering also the circumstance," says M. Exner, "that tellurium at ordinary temperature has a strongly crystalline structure, there can hardly be a doubt that all the abnormal phenomena depend on the molecular character in each case; they are also fully explained if we suppose that tellurium conducts worse, the more pronounced its crystalline structure; a supposition which *a priori* has nothing in it improbable. If we make this hypothesis, then *two factors* must be taken into account, as determining the resistance—first, the change of molecular state; and second, the direct change of temperature." He then points out that the crystal surfaces and planes of cleavage probably increase the resistance, and that circumstances preventing or destroying crystallisation (such as heating) must diminish the resistance. Heating also acts by causing a more intimate contact of the crystalline particles through expansion. Quick cooling must diminish the resistance, for it hinders the crystallisation; slow cooling has the opposite effect. Immediately after solidifying from the fused state (which process was rapid), the tellurium bars had a less crystalline structure than after the slow cooling from 200°, and their resistance was then very small. Compare also the fact of the turning point; where the crystallisation is but little, the influence of heating only becomes perceptible at the higher temperatures. At the lower, the influence of heating predominates in the direction of an increase of the resistance. Thus the direct influence of heating on tellurium acts in the same direction as in all other conductors of the second class, and the abnormal phenomena are only a consequence of secondary processes, molecular changes of structure.

M. Exner determined the specific conductivity of tellurium. Taking the conductivity of silver at 0° = 100, that of Bar II. at 200° = 0·00351, and Bar III. = 0·00310. At 20° the conductivity of Bar II., after fusion, was 0.00286, and after the slowest cooling, 0·000435; in Bar III., after fusion, = 0·00298, and after slow cooling, 0·000437. The close agreement in conductivity after slow cooling, in the two bars, seems to prove that in the experiments with slowest cooling, the crystalline state of the tellurium had already reached its maximum.

Mr. John Byron, late managing director of Greville's Australian Telegram Company, has sailed for Sydney, in order to give a much wider personal supervision over the Australian branches of that Company. The London business is carried on at their old offices, 9*a*, New Broad-street, where all messages should be addressed, marked "viâ Greville's Australian Company."

TORPEDOES AND TORPEDO WARFARE.

BY J. A. BETTS, M.S.T.E.

(Concluded from page 295.)

THE torpedoes hitherto spoken of must all be considered as purely *defensive;* but the torpedo engineer, not being content to rest here, has devoted his energy to the invention of torpedoes with which he can assume the *offensive*; such are:—

Whitehead's "Fish" Torpedo.
Erricson's Torpedo.
Drifting Torpedoes.
Harvey's Sea Torpedo, and Torpedo boats.

The "fish torpedo" consists of an iron fish-shaped case—the front part or head is fitted with a percussion fuze communicating with the charge. The after-part or tail is supplied with machinery for working a screw by air compressed to about 200 lbs. to the square inch, which is contained in a chamber in the centre of the case. The torpedo is launched from the shore or ship, and drives through the water, some few feet below the surface, at a fair speed. The greatest distance it is capable of travelling with effect is some 600 yards. Its greatest objection is that it is costly in its manufacture, and difficult in its manipulation.

Erricson's Torpedo is somewhat similar in construction, but is controlled from the vessel launching it by an indian-rubber tube, supplying the motive power—compressed air—which is paid out behind it, as it drives through the water.

Harvey's Sea Torpedo is intended for use on board ship when engaged in action with the enemy, or pursued by another vessel; it is a floating case manœuvred by lines from the yards of the vessel carrying it, and explodes on contact with the enemy's ship. It is effective only at distances not exceeding about 200 yards, and could very rarely be brought into use with any degree of success—if the enemy kept his eyes open.

Drifting torpedoes may be used with most deadly effect against vessels riding at anchor in rivers or tide-ways. They should be submerged some feet below the surface, and allowed to drift down with the tide. If launched in pairs, with a light line connecting them, they are likely to explode on both sides of a vessel, the line being caught by her cable. The only fear is that some may *return* by the next tide, and "hoist the engineer with his own petard." An *electrical* drifting torpedo, invented by the writer, obviates this difficulty in a very simple manner.

Torpedo boats.—Many attempts have been made to construct submarine boats for offensive torpedo warfare, and although much thought and perseverance has been devoted to the subject, none of the projectors have been fully successful. Lieut. Dixon, of the Confederate service, invented a submarine boat in which he proposed to attack the Federal fleet. Two attempts were made to use her, but each time she drowned her crew of four men. In the third attempt, with Lieut. Dixon on board, she succeeded in sinking the Federal steamer "Housatonie," off Charlestown, but the boat with her brave commander and crew went down with her. During the same war, steam-launches were used; these launches were fitted with silent engines capable of steaming twelve knots an hour; they were rigged up with a spar twenty to twenty-five feet long, projecting from their bows, the end of the spar carrying a torpedo dipped some eight or ten feet below the water, and fired electrically, when in contact with the vessels attacked. The launch was covered in with a steel bullet-proof shield for the protection of the crew. The attack was made at night, under cover of the darkness, and owing to the high speed and small size of the launch proved most formidable. Although in most cases where the attack was made it proved successful, the launch and her gallant crew went down too; this was so well understood, that "Torpedo boat" service was looked upon as the most "forlorn" of "forlorn hopes." Nevertheless, there was never any lack of volunteers to man them. There is little doubt that the loss of these launches was due to imperfections in the manufacture of the boat itself, which have now been overcome; as in one case it is known that the launch was swamped by the column of water thrown up, falling back in her; in another instance, the launch was found wedged in the hole she had made in the side of the vessel attacked—sinking with her.

One most gallant attack must be recorded. Lieut. Cushing, of the United States Navy, started with a crew of about twelve men, to attack the Confederate ram "Albemarle," lying under the protection of her own forts; after hiding all one day in a creek, the attack was made at night; the launch was seen by the officer of the watch when about fifty yards distance from the vessel, and a heavy fire opened on her with rifles and revolvers. The launch steamed straight at her in spite of everything, and succeeded in firing the torpedo with effect, the "Albemarle" sinking in about ten minutes; but not before she had killed or wounded the whole of the crew of the launch, the only one who escaped being Lieut. Cushing himself, who states that at the moment of the explosion he jumped overboard, and, though badly wounded, managed to drift with the tide down the river, and gain the shelter of some swamps, where he remained hidden for two days, suffering severely from his wound, exposure, and hunger, until he was found by a friendly negro, and conveyed to his ship. With the improvements now made, the boats could be used with a fair chance for the men employed; and their importance is so fully appreciated, that England, America, Prussia, and other countries have each built a considerable number, although England is more in favour of employing ordinary ships' cutters specially fitted for the service.

In every system of torpedo defence, the attention and consideration of the torpedo engineer must first be directed to obtain an accurate knowledge of the ground, whether rock, sand, or mud, depth of water, rise and fall of the tide, strength and direction of the surface currents, &c. In every particular a careful and minute survey of the area to be defended must be made. With heavy artillery, the action of the wind upon the flight of of the projectile has to be taken into considera-

tion, in relation to the strength of the charge; and so with the torpedo engineer the velocity of the current, and the depth at which the torpedo should be submerged, forms an equally important feature in the effective manipulation of the mine. Every precaution must be taken to moor the torpedo in such a manner that it may be able to withstand the tides and currents for many months, if necessary; this is especially essential with buoyant torpedoes, which are naturally more exposed to the dragging action of the tides than torpedoes resting on the bottom. Nothing but an intimate knowledge of the nature of the ground can secure this, and it will be at once apparent that any deviation from the place originally assigned to it would be absolutely fatal to the effective discharge of the mine for destructive purposes.

Unlike the employment of artillery in warfare, where each piece can be brought to the front after successive discharges, a torpedo once fired when the action is on, and non-effectual in its results, may be looked upon as a victory gained by the enemy. That position is lost, and becomes a safe standing ground in the advance for the attack. It is therefore evident that every precaution to insure accuracy must be initiated with the system of defence, which should be so constituted that should the enemy escape destruction by one explosion, he will be within the reach of the area of destruction of the next series of mines as he advances.

A system of lighting up channels or water-ways at night, by means of the electric light or the lime-light, has been adopted by the English Government, and will be found of great value; a small lime-light is also used for signalling, which, by means of the flashing code, enables direct communication to be maintained with the picket-boats on the look-out, some four or five miles away.

In carrying into effect the laying down of any system of torpedoes for a defence, it is of the most vital importance that strict secrecy should be observed in all its details, and no strangers should be permitted to see the plans and charts in use; every torpedo station should itself be mined, and destroyed at the last moment if it can no longer be held from the enemy.

In speaking of torpedo warfare in this paper, the system must be regarded in the light of an established national defence, auxiliary to that of armour-plated vessels and forts, and not as a defence of an impromptu nature, devised at the moment a country is plunged into war. The writer advocates the establishment of a permanent torpedo corps with a school, stores, forts, observing stations, &c., as an essential element in the successful defence of any nation possessing an extended sea-board and large navigable rivers. China is a nation peculiarly adapted for such a defence; and it is but one more proof of the awakening of this vast empire to the advantages of Western progress, that His Excellency the Viceroy of this province should have been the first to found a College for the instruction of a corps of Torpedo Engineers, of which the writer has the honour of being director.

Notes.

AT the opening meeting of the Glasgow Philosophical Society last month, Sir W. Thomson delivered a lecture on Dr. Ker's electro-optic and magneto-optic discoveries, and their relation to Faraday's previous investigations in the same field. He showed, by experiments, the effects of magnetism on polarised light, and discussed the theory of the phenomena. (We invite a thoughtful perusal of Prof. Barrett's able paper on the same subject, part of which appears in our present issue.)

A communication from Prof. Langley, read at the opening meeting of the Royal Astronomical Society last month, described some experiments made to determine the difference of the heat radiated by a unit of area of sun-spot umbra, a unit of area of sun-spot penumbra, and a unit of area of the photosphere. The object was to ascertain the difference in the amount of total solar radiation which might be expected in a year of maximum sun-spot frequency, and in a year of minimum sun-shot frequency. A galvanic pile was enclosed in a darkened chamber, kept at a constant temperature by hot water receptacles; and the pile was carefully screened, so that small areas of the sun's disc could be thrown upon it. The general result arrived at was, that the total difference of radiation (between maximum and minimum sun-spot frequency) would amount to only ·0009 of the total radiation, and the whole effect upon terrestrial temperature would, at most, be represented by a difference not exceeding three-tenths, and not less than one-twentieth, of 1° centigrade. (Prof. Langley considers the total heat radiated by the sun to be greatest at a period of sun-spot minimum; and this point was disputed in the interesting discussion which followed the reading of his paper.)

The Annual General Meeting of the Society of Telegraph Engineers will be held at 25, Great George-street, on Wednesday, the 13th inst. The Report for the past year will be read, and the new Members of Council and office-bearers for the next year will be elected. It is rumoured that Professor Abel, F.R.S., is to be nominated for the position of President. We can only hope that the rumour is more correct than rumours usually are, for there is no name more universally respected in the scientific world than that of Professor Abel, and no one more deserving of, or better qualified to fill, the position than he is.

We have pleasure in announcing that Mr. E. C.

Cracknell, Superintendent of Telegraphs in the colony of New South Wales, has been appointed the Honorary Secretary for Australia, of the Society of Telegraph Engineers. Mr. Cracknell, who has been in England for some time, returns shortly to Australia, carrying with him the best wishes of everyone with whom he has come in contact. During his brief stay he has visited all the large telegraph factories, and we believe that he now takes out with him specimens of everything in the shape of an improvement in telegraphy which has been made since his previous visit to this country.

Speaking of improvements, it is a question whether our telegraph engineers at home might not with advantage "take a leaf from the book" of some of the colonies. We have been favoured with a few statistics, showing the state of insulation on some of the Australian lines. In no case does it fall under 190 megohms per mile, whilst in some it reaches the marvellous result of 1,690 megohms per mile. The tests were taken by Mr. Charles Hockin, during his recent stay in Sydney, so that implicit reliance may be placed on these figures. The insulator employed is the white porcelain in the form known as Oppenheimer's. Nothing but white porcelain is now being used, and the brown earthenware, previously in existence, is rapidly being replaced by it. Still, the brown earthernware has been, and is, most extensively employed in England; it would be interesting to know from some statistics of the state of insulation on our English lines, whether the colonial experience is borne out at home, and if not, what advantages the brown earthenware possesses in England which are denied to it in Australia.

The German telegraph authorities are about to lay a direct cable between Berlin and Kiel.

The magneto-electric machines of the Loan Collection formed the subject of a lecture delivered by Prof. G. Carey Foster at South Kensington Museum on the evening of Saturday, the 11th ult.

A new arrangement is about to be tried in the German telegraph system. Telegrams may be sent to places within the empire, for further dispatch (beyond the receiving office) by the post as ordinary unclosed letters. The sender has merely to intimate his wish by a mark placed before the address, or by the letters P U (Post uneingeschrieben), charged as one word; and to pay 10pf. as postage. The authorities do not hold themselves responsible for delays with these messages.

We have before us a little pamphlet, "How to learn the Morse alphabet in half an hour," (London, Marlborough & Co.) The guide, we may state, is at once "alphabetical, phonetical, and mneumonical,' and whether it will do all it professes or not, it should undoubtedly, we think, facilitate an acquisition which often takes some time.

From the Annual Report of the Telegraph Electrical Society of Melbourne, we observe that the society completed its second year on the 31st July, and it appears to maintain its position satisfactorily. The membership is 138. Eighteen meetings were held during the year, for reading papers or experiments. The Journal (May to July) contains *(inter alia)* an account of the arrangement of circuits and commutators in the chief electric telegraph office, Melbourne, and another describing Mr. Hockin's observations, while in New South Wales, on interference between lines as connected with the working of the automatic system.

The New Zealand Government supports the proposal for a second cable line of communication with Europe, provided that it is completed by a second line through Australia; but it regards a Trans-Pacific route as out of the question.

The Eastern Telegraph Company notifies the restoration of telegraphic communication with Singapore, China, and Japan. Telegrams for transmission by this route should be ordered "viâ Eastern." The same Company announce the repair of the Brazilian Company's cable between Lisbon and Madeira, thus restoring communication with Madeira, St. Vincent, and South America.

The Indo-European Telegraph Company also announces that the Penang-Singapore cable is restored, thus re-establishing direct telegraphic communication with Singapore, Cochin China, China, and Japan. All telegrams should be marked "viâ Indo."

The Direct Spanish Telegraph Company notify that arrangements have been made by which telegrams destined for transmission by their Direct Spanish Cable may now be handed in at the office, 106, Cannon-street, E.C., where receipts for the amounts charged will be given without additional cost, and where monthly accounts for telegrams may be opened.

The Great Northern Company's Amoy-Shanghae cable is restored; likewise the Santiago-Jamaica cable of the West Indies and Panama Telegraph Company.

The Brazilian Submarine Telegraph Company have announced that the Lisbon-Madeira cable has been nterrupted near the Portuguese shore.

The Western and Brazilian Telegraph Company also announce an interruption between Bahia and Rio de Janeiro.

TRAFFIC RECEIPTS.

Direct United States Cable Company, week ending 11th November, £3,450; 18th, £3,700; 25th, £3,840.

Brazilian Submarine Telegraph Company, for October, £9,684, against £10,503, in the same month last year.

Western and Brazilian Telegraph Company, for October, £8,319, against £9,652.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

THE opening meeting of the Society for the current session, was held at The Institute of Civil Engineers, 25, Great George-street, Westminster, on the evening of Wednesday, the 22nd ult. The President, Mr. C. O. Walker, F.R.S., was supported in the chair by a full meeting of the Council, and a large number of the Members and Associates were present.

The President having addressed a few words of welcome to his audience at the recommencement of a new session remarked upon the favourable prospects which it held out. During the recess many valuable communications had been received, amongst others a most rare and interesting document from Professor Oersted, of Copenhagen, in the shape of an authenticated copy of the original paper in which his father announced to the world his discovery of electro-magnetism. This, it was intimated, was written in Latin, and would appear along with a translation in the next number of the *Proceedings* of the Society.

The Acting Secretary then proceeded to read a lengthy list of candidates for election as Foreign Members, Members, or Associates; giving the most convincing proof, had any been required, of the healthy condition in which the Society is.

The adjourned discussion upon Mr. Latimer Clark's paper on "Thermo-electric Batteries" (a *resumé* of which appeared in THE TELEGRAPHIC JOURNAL of June 1st, 1876), was then resumed, by the President calling upon the author for any further remarks he might wish to make on the subject.

Mr. Clark proceeded to explain a new form of thermo-electric battery, the joint invention of Mr. Cecil Wray and Mr. Leonard Wray, Jun. One of these batteries, along with the various portions of it, was exhibited. The improvements which are claimed for this form over that of Mons. Clamond may be classed under the following heads:

a. Casting of the bars.
b. Building up of the battery.
c. Arrangement for heating the pairs.
d. Regulation of the draught.
e. The coke furnace.

a. The alloy employed is the same, or very nearly the same, as that adopted by Clamond, consisting of two parts of antimony to one of zinc. The positive metal is likewise the same—viz., sheet-iron. The brittleness or liability to fracture of the alloy is, however, overcome to a very great extent in Messrs. Wray's form, by the peculiar shape of the positive metal. The sheet-iron has an elongated tongue, which extends to a distance of about two inches. This is placed in the mould into which the alloy is cast under pressure, the bar being about three inches in length. The effect, when completed, is to heighten the breaking strain to a marked degree, the relative proportion with this and the original form being 51 and 31 pounds. It would appear at first sight that while the internal resistance of the pair would be undoubtedly diminished, the electro-motive force would also be diminished. Strange to say, however, this is not the case, Mr. Leonard Wray, Jun., having stated afterwards, in reply to a question from Professor Foster on the point, that the reverse actually happens, the electro-motive force being increased, while the internal resistance is at the same time lowered. No reason could be assigned for this.

b. In the building up of the pile there is an essential difference between this and the original form. In the latter the bars were secured in their position by a paste or cement formed of powdered asbestos and soluble glass, or solution of silicate of potass; and as soon as one circle was completed, a ring formed of the same composition was laid upon it, and another circle of elements built upon this. It will thus be seen that each circle of bars had to bear the superincumbent pressure of all the bars laid above it; as the pairs at their heated junction were heated to a very high temperature, and so became to some extent viscous, this pressure caused the metal to ooze out, and so accounted for the deposit of the metals observable at the foot of the furnace, after a Clamond's pile had been for some time at work. The Messrs. Wray discard this composite pasté altogether, and adopt in its place rings of the best earthenware. Instead, however, of allowing these rings to rest directly on the pairs immediately beneath them, they employ triangular supports, also of earthenware. Three of these are employed on each ring, the disc being thus divided into sections of 120 degrees each. Through the small triangular supports pass binding-rods, which serve to give additional stability to the structure. The bars are inserted between each pair of rings.

c. It is in the heating arrangement, perhaps, that the main improvements are claimed for this new form of thermo-electric battery. The main complaint brought against Clamond's pile, and, in fact, against every pile which has ever been introduced, was that no combination could ultimately withstand the intense heat, and the action of the gases forming the products of combustion of whatever was employed to heat the pile. Clamond endeavoured to overcome this by introducing the iron cylinder, and so preventing the flames from impinging directly on the ends of the bars. They were heated by radiation from the cylinder, and by the hot air passing down between them and it. This was admitted to be a decided improvement, but the evil of oxidation from the action of the gases and the ultimate danger of disconnection from the bars being eaten through still existed. Messrs. Wray claim to have got rid of this entirely by the mode of heating which they have adopted. The bars are by them arranged around an earthenware cylinder, against which they abut; the chimney is placed inside this cylinder, which is heated direct from the gas consumed in it. The ends of the bar are thus free from the direct action of the flame, and they are also protected from the injurious effects of combustion. But not only this: the rapid cooling so injurious to the bars in Clamond's form is not to be found here; the bars cool gradually with little danger of their structure being altered; the condensed moisture so frequently observable on the faces of the exposed bars before the gas is re-lit is not to be met with when they are protected in this way.

d. In any form of thermo-electric battery, one of the most essential points to be borne in mind is that the heat applied to the ends of the bars should be as far as possible *uniform*. Unless this is attained the value of

every pair will vary, and the effect will be the same as is found in a galvanic battery, whose cells have all a different electro-motive force or a different internal resistance. In order to arrive at this uniformity, a regulator is applied at the bottom of the earthenware cylinder, and in this way the supply of air may be increased or diminished at will. This regulator consists of a circular brass plate working upon a screw, by means of which it can be placed as close to the cylinder as may be needed. With the cylinder open at the bottom, the tendency is for the heat to be carried away from the lower circles of bars, and concentrated on the upper strata. A perforated circular plate of earthenware, with a cover of the same material, is also placed over the cylinder for the same purpose.

c. In countries where gas is not procurable for heating purpose, coke or charcoal can as a rule be readily obtained, and these have been employed with great success in the thermo-battery. The main objection to their use hitherto has been the difficulty of regulating the heat in the furnace. "Clinkers" form, and the coke or charcoal will in time "arch" up. The only method of removing the clinkers has been by withdrawing them from the top of the furnace. Messrs. Wray have introduced a furnace—a finished model of which was exhibited—fitted with vertical doors, or windows, rather, with sliding bars. The condition of the fire can thus be readily seen, and whatever steps are necessary to ensure uniformity of heating may at once be taken.

Mr. W. H. Preece, remarked upon the employment of Clamond's pile by the Postal Telegraph Department. Five of these had been used for some time at the Central Telegraph Station in St. Martin's-le-Grand, to work 90 circuits all under 100 miles in length. They did the work of 2,535 battery cells. The experience there gained tended to confirm almost exactly the figures given by Mr. Clark in his paper, with regard to the electro-motive force, internal resistance, and quantity of gas consumed in heating them. The defects due to the over-heating of the pairs already remarked upon had made themselves apparent, and the thermo-batteries were no longer employed. He had little doubt, however, that the subject was still in its infancy, and that when these defects were overcome, as they in course of time would be, the thermo-battery would be extensively made use of, not only in telegraphy, but in the other branches of art indicated in Mr. Clark's paper.

Mr. Cecil Wray, Mr. Leonard Wray, Jun., and Mr. Leonard Wray, Sen., then having explained more fully the various points in the form of battery brought forward by them, the discussion was terminated by a few concluding remarks from the President.

A paper by Mr. Andrew Jamieson, of the Eastern Telegraph Company, "On a new form of Lightning Protector for Telegraph Lines and Apparatus," was then read. The author commenced by showing at some length the necessity which existed for all circuits being protected from the injurious effects of lightning. Although no case had come under his own personal observation, in which a line entirely buried had suffered from lightning, he could still quote an instance (communicated to him by M. Gerhardi, of the Direct Spanish Company) in which the apparatus upon a line wholly underground, and connected in no way with a system of open wires, had been damaged by the inductive effects of lightning. He then proceeded to show the principles upon which an efficient lightning-protector should be based, quoting largely from the "Experimental Researches" of Faraday upon this subject. Having alluded to the forms of lightning-protector generally employed at the present day, he incidentally remarked upon the nomenclature which is adopted, and suggested that the general class "protectors" might with propriety be divided into "Lightning Guards" and "Lightning-Arrests." The guards would include those in which an effort was made to trap the lightning, as is done in Siemens' well-known plate form, P, Varley's vacuum, &c., while the term "Arrester" would be applied to those which actually succeed in stopping the lightning, such as the fine-wire protector, &c. Both guards and arresters are generally employed for the protection of cables; where such is the case, the guard should be always between the line and the arrester. In this way the potential of a heavy lightning discharge, if not actually reduced to zero at the guard, would have at least a chance of being largely diminished before it reached the arrester, and there would then be less likelihood of the fine wire being fused, and the circuit consequently broken down by it. The condenser now generally used in working cables of any length often played the part of an efficient lightning-protector, and no authenticated case of a line being damaged on which condensers were joined up had yet been placed on record.

The author then proceeded to explain the form of protector specially designed by himself when in the service of the Western and Brazilian Telegraph Company, and adopted for the protection of the apparatus at several of the stations of that Company, where thunderstorms were rife, and the injuries from lightning, when other forms of protector were employed, frequent. The protector now shown was in reality a guard and arrester combined, uniting, as it does, the principles of the rectangular-grooved plates and the fine wire. It consists of a brass cylinder, with, say, twenty grooves cut longitudinally along its internal surface, and put to earth. Inside this is another cylinder, whose external surface is likewise grooved, but in a direction at right angles to that of the outer cylinder: the two cylinders are placed as close as they mechanically can be to each other, and are prevented from actually touching by the interposition of ebonite washers. To a binding screw at one end of the inner cylinder the line wire is brought, and continued on by means of a fine platinum wire, which is wound spirally around the outer cylinder. There are thus—supposing the number of grooves cut in each to be twenty—400 points at which the potential of the discharge may be lowered, and there is at the same time the action of the fine platinum wire in addition, to guard the cable or apparatus.

The Acting-Secretary then read a communication from Mr. Webber, the Superintendent of Telegraphs on the South Devon Railway, describing two forms of lightning-protectors devised by him, and used with success on the lines under his charge. One consisted of a small circular brass box, which was put to earth. Inside this box, and as near as possible to its inner surface, a divided ring with sharpened edges is placed. To each side of the ring the line (or earth) and instrument wires are brought. The two halves of the ring are insulated from each other and from the box by means of gypsum. This after a few days hardens, and while acting as an insulator for electricity of low potential, yet aids a lightning discharge to spring from one plate to the other or to earth without damaging the apparatus. In the other form, three bars with opposing teeth cut in them, and placed as close as possible to each other, are used: the central bar is put to earth; while the line and instrument wires are brought to the other two. The space separating the bars is filled with fine powder, somewhat similar to that used in Varley's *carton* protector, and fixed with gum-water.

Specimens of all the lightning-protectors described were exhibited, and there was at the same time a large display from the firms of Messrs. Warden and Co., Messrs. Siemens, and Messrs. Varley, of the various

forms manufactured and employed at the presen day.

The discussion on the subject was adjourned until the next meeting, to be held on Wednesday, the 13th inst.

PHYSICAL SOCIETY—18TH NOVEMBER, 1876.

Prof. G. C. FOSTER, President, in the chair.

THE following candidates were elected members of the Society:—Major W. Malcolm, R.E., Prof. J. M. Purser, Dr. W. Francis, Mr. G. Johnstone Stoney, and Mr. D. MacAlpin.

MR. TYLOR read a paper on the "Cohesion and Capillary Action of Films of Water under Various Conditions." The author endeavours to eliminate the action of all forces except that of gravity, by immersing his "valves" in water. The models which he exhibited consisted of glass tubes about three inches in diameter and six inches high, filled with water, and containing each a piston which, on being raised, was capable of lifting by cohesion a heavy mass of metal, the nature of the surfaces in contact differing in the several instruments. From experiments with them he concludes that the time during which a heavy valve can be supported depends upon the size of the surface of contact, the difference of pressure within and without the moving parts, and the smoothness of the valve. On the contrary, dry bodies, such as Whitworth's surface planes, will adhere for an indefinite period. Mr. Tylor considers that the supporting of a body in water is due to a difference of pressure in the water itself, and he adduced Giffard's injector as showing that such differences can take place. He has also studied the form assumed by a drop of water at a tap, and considers that when a fly walks on a ceiling its weight acts in the same manner as the heavy valves in the models exhibited,

PROF. SHELLEY exhibited some of Sir Joseph Whitworth's surface planes and guages, and showed their bearing on the subject,

DR. STONE then projected on to the screen the spectra produced by the diffraction gratings which he exhibited at the last meeting of the Society. Mr. Clark has since ruled for him gratings on the backs of right-angled prisms, and Dr. Stone has cemented, by means of glycerine or oil of cassia, gratings on glass and steel on such prisms. The lines were two thousand and three thousand to the inch.

Electrical Science in Foreign Journals.

COMPTES RENDUS OF PARIS ACADEMY.

No. 19: 6TH NOVEMBER, 1876.

Researches on the Production of Electro-Chemical Deposits of Aluminium, Magnesium, Cadmium, Bismuth, Antimony, and Palladinm. BY M. BERTRAND.

HARDLY suited for abstraction. The author experimented with the following liquids:—For *Aluminium:* double chloride of aluminium and ammonium. *Magnesium:* double chloride of magnesium and ammonium. *Cadmium:* chloride of cadmium, double chloride of cadmium and ammonium, double chloride of cadmium and calcium, bromide of cadmium, double bromide of cadmium and ammonium, double iodide of cadmium and ammonium, sulphate of cadmium, double sulphate of cadmium and ammonium. *Bismuth:* double chloride of bismuth and ammonium. *Antimony:* double chloride of antimony and ammonium. *Palladium:* double chloride of palladium and ammonium. The effects of experiment are detailed.

On a New Dynamo-Magnetic Phenomenon. BY MM. TREVE and DURASSIER. Reserved.

No. 20: 13TH NOVEMBER.

Influence of Temperature on Magnetisation. BY M. GAUGAIN.

IN two bars of same nature, same section, and different lengths, the co-efficients of temporary variation corresponding to points similarly placed (middle points, *e.g.*), increase with the length of the bar. These co-efficients vary much, even in similar bars from the same works. The co-efficients of permanent and temporary variation are less in iron than in steel. To determine the influence of temperature, it is necessary that this be invariable during each experiment. M. Gaugain proceeds thus:—He takes a bar of steel, puts it in contact, at ordinary temperature, with one pole of a permanent magnet, and determines the value of total magnetisation for a certain point, M, of the bar. Then he demagnetises the bar, raising it to a cherry-red temperature; when it has cooled, he heats it with a spirit lamp, so as to bring it to about 300°; only then does he put it in contact with the magnet, and without allowing it time to cool again, measures once more the total magnetism at M. It is found that if the bar is capable of considerable temporary variation, the magnetism developed is weaker at 300° than at ordinary temperature. But when the temporary variation is very small, the magnetism is greater at 300° than at ordinary temperature. If we correct the values of magnetism obtained at different temperatures, so as to eliminate the effect of temporary variation, it is found that for both bars the corrected magnetism increases with the temperature.

On a Meteoric Iron, very Rich in Nickel, found in the Province of Santa-Catharina (Brazil). BY MM. GUIGNET AND OZORIO DE ALMEIDA.

JOURNAL TÉLÉGRAPHIQUE.

25TH SEPTEMBER, 1876.

Resistance of the Earth in Telegraphic Circuits. BY M. DU. MONCEL.

WE have noticed this investigation elsewhere.

On the Theory of Translation (concluded). BY M. ZETZSCHE.

THIS is a comprehensive and useful paper.

Critical Examination of M. Schaak's Supplement to his Article on Mathematical Definition of the Points of Derivation in Telegraphic Wires. BY M. NYSTRÖM.

25TH OCTOBER.

General Considerations on Telegraphic Tariffs (concluded). BY M. VINCHENT.

HAVING established certain rules, he here inquires how far they have been observed in the formation of the present international tariff, and in the resolutions adopted by the Telegraphic Conference in St. Petersburg.

The Latest Improvements in the Hughes Apparatus, and a New Method of Translation with this Apparatus. BY M. DE HEFNER-ALTENECK.

HITHERTO special accessories have had to be furnished to Hughes' apparatus, meant for automatic re-transmission from one line to another. There would be no use, but even inconvenience, in placing the apparatus thus furnished at stations which do no translation. Hence the employment of two systems of apparatus, the one for translation, requiring operators specially initiated, and the other simple apparatus only used at extreme stations. The method here described remedies the disadvantages of this, with the aid of two improvements in the Hughes' apparatus. One (devised by Hughes' himself) consists in transferring the working and insulated contacts of the turning chariot to a lever fixed to the stand of the apparatus, and which reproduces the up and down movements of the chariot. This is a simpler arrangement, and gives more certain contacts. The other improvement is the purely mechanical ungearing of the printer axis in the transmitting apparatus, excluding all electro-magnetic action of the sending current.

Submarine Key of M. Sommati.

THE object is to neutralise, at each emission of the current, the effects of charge of the cable. (M. Sommati applies the principle of it, also, to Siemens relays, employed in translations, and Hughes apparatus, working on long lines.) A reversing battery is, by means of an auxiliary lever, made to act momentarily when the key is returning to the state of rest, and before it has reached it. The editor considers the arrangement will probably work well on short submarine cables, not on long ones. The idea of the small auxiliary lever bringing into action a reversing battery is not new.

A Coup-d'Œil of the Exhibition of Hygiene and Life-saving Appliances at Brussels. By M. CHARLIER.

He notices shortly the electrical apparatus from different countries.

Application of the Circuit of Compensation to the Sixth Combination of the Vianesi System. By M. VIANESI.

THE object is to protect the magnetism in the receiving apparatus against the effects of the charging current, which tends to weaken it in the moment of passage from the simple reception to the simultaneous reception.

Obituary Notice of Prof. Gloesener, of Liège.

Reviews.

Oakum Pickings. A Collection of Stories, Sketches, and Paragraphs, contributed from time to time to the Telegraphic and General Press. BY JOHN OAKUM. New York: W. J. Johnson, 1876.

THE author of this little book, who appears under the *nom-de-plume* of "John Oakum," is a telegraph operator, who has devoted a portion of his leisure to essays in literature. It is a book somewhat novel in its subject—most of the sketches being of odd characters in the telegraph profession; and to those who are aware, from experience, how much there is of the odd, pathetic, humorous, and startling, in the ordinary life of a metropolitan telegraph office, it will have a special interest. It is also interesting from its peculiarly American character, and the glimpses it affords at telegraph office life in that country. The sketches are of unequal merit; in some the wit is rather "dilute," and there is an occasional flavour, we are afraid, of the vulgar; in others, we have delineations of character that are really clever and graphic, penetrated by a vein of quaint humour, and, occasionally, pathos. The unprofessional reader will, perhaps, sometimes stumble over expressions which require for their comprehension, now some acquaintance with telegraphy, now a slang dictionary—but these will not materially compromise his enjoyment of the "unconsidered trifles" Mr. Oakum has gathered.

Lessons in Electricity at the Royal Institution, 1875-6. BY JOHN TYNDALL, D.C.L., L.L.D., F.R.S., Professor of Natural Philosophy in the Royal Institution of Great Britain. London: Longmans, Green, and Co. 1876.

THE Christmas lectures on scientific subjects to boys and girls at the Royal Institution are an important feature in the mental feast annually provided at that classical place. Last year it fell to Prof. Tyndall's lot to give one of these courses, and the present little book contains, with some amplification, the substance of his lectures. A report of this course appeared in our columns at the time. We may here specially note the simplicity of the experiments described, the apparatus required being so simple and inexpensive as to be within everybody's reach. The author's well-known skill in experimentation, and in the art of leading on the mind of the student from the simple to the complex, needs no commendation here; and we have merely to add that, with its clear descriptions and numerous well-executed engravings, this is a book which not only may well delight the heart of boys, but may be read with profit by anyone who wishes to be indoctrinated in the principles of electrical science.

WE have to acknowledge receipt of the "Quarterly Journal of the Meteorological Society;" "Journal of the American Society of Civil Engineers;" Reprints of papers by Mr. Sabine and Mr. Lodge, in *Philosophical Magazine* for November; "How to make Money by Patents."

Correspondence.

THE AUTOKINETIC TELEGRAPH.

IN my letter of the 16th September, that you were kind enough to insert in your pages, under the above heading, I was careful to avoid statements calculated to injure the prospects of a rival system, whatever my opinion respecting its merits may have been, and confined myself to a short exposition of this company's single-wire system, the claims of which, from a previous notice in your columns, I judged you to be unacquainted with; the inspection which followed, and your foot-note to my letter, confirmed me in this opinion, and I felt satisfied.

It would now appear, from a letter in your issue

of the 1st instant, signed "A. M. Moir, one of the Concessionaires of the Autokinetic Telegraph," that in thus bringing our system to your notice I made some statements which that gentleman considers incorrect, as he requests space to refute them, "and to point out, also, wherein lies the great superiority of the extremely ingenious Autokinetic Telegraph."

Had Mr. Moir carried out his programme, I should not have troubled you again; but as, by a supercilious expression of opinion, he has neither refuted my statements, nor shown the superiority of the system which he advocates, I must again ask you to allow me room for a few remarks, promising to be as brief as the circumstances will permit.

The system which Mr. Moir is pleased, rather inaccurately, to say I am "endeavouring to introduce here," for I simply seek to extend its use, we have had in active operation since October, 1874, there being no less than 500 signals upon three circuits, leading into one office, and out of the many thousands of signals received up to the present time, we have not had a single complaint that could possibly be attributed to the breaking in of one signal upon another; therefore my statement that "no inconvenience whatever is experienced in practice from this cause," and at the temerity of which Mr. Moir expresses his surprise, is confirmed by actual experience; and should signals at any time become too numerous, and although we have suitable and effective non-interruptable instruments to obviate the difficulty, we should certainly prefer to provide other channels for them, rather than they should be delayed, as by the Autokinetic system.

The ordinary single-wire system referred to by Mr. Moir as having been the cause of a railway accident, for lack of the Autokinetic properties, and upon which "every telegraphist is so fully aware, interruptions occur," is evidently the single needle telegraph, which bears no sort of resemblance to our Automatic Call system; but bad as that may have become in the hands of undisciplined and mischievous youths, it is not at all likely to be superseded by the Autokinetic, as, setting aside the necessity for two wires, and expensive transmitting and recording apparatus at each station, the difficulty attending the composing and setting up of the various messages for automatic transmission will always prove an insuperable objection to its use for general railway telegraphy.

The simile used by the President of the American District Telegraph Company, at which Mr. Moir sees fit to cavil, was in defence of the discontinuance of the means used for preventing interruptions in instruments of recent construction for their rapidly extending system; Mr. Moir's assumption that it was required to bolster up an inefficient system is therefore equally incorrect with the generality of his statements and surmises. The American Company, with its branches, now number their instruments by tens of thousands, and the president of such an enterprise must surely be better qualified to give an opinion on the subject than those totally unacquainted with the electrical, mechanical, and business details and conditions of the system.

The supposition that our system is adapted only to short circuits, with comparatively few houses in circuit, and that a gigantic battery of extravagant cost is necessary to overcome the resistance of the instruments alone, is disproved by the fact that, by means of a relay, we work through any length of circuit, workable with the ordinary Morse or Siemens ink-writer, the resistance of each instrument being less than $\frac{1}{100}$ of a B. A unit, and Mr. Moir and his friends saw at one of our branch offices four lines and three local circuits, working from a battery which occupied less than one cubic foot of space.

We invariably use the closed, in preference to the open circuit, in order that we may be instantly made aware of any rupture of continuity of the line-wire, and also to diminish the tendency to leakage over, or through, the insulating supports or covering; in addition, the freedom, or otherwise, of the line from earth faults, can be readily tested up to the last instrument, without the operator leaving his post.

Our system is, moreover, not limited to the transmission of only three or four signals, but will signal the letters of the Alphabet in the Morse or even Roman characters, if necessary, with 500 instruments and hundreds of miles of line in circuit.

Lastly, when the "talented inventor" first introduced his system to our notice, I presume before Mr. Moir became "one of the Concessionaires," we explained to him how that we were then doing with one wire what he proposed to do with five; we now find him reduced to two, so that it is probable he profited by the information, and that we shall ere long see an Autokinetic "*one* wire system," his improvements tending as they do in that direction.

I am, &c.,

W. HENRY DAVIES, Managing Director.

The Exchange Telegraph Company, Limited.
17 & 18, *Cornhill, London, E.C., Nov.* 16, 1876.

[We have had the pleasure of inspecting this Company's improved system, and it certainly effects with *one* wire what the Autokinetic system does with two. Apart from the question of diminished liability to interruption by the use of one wire in the place of two, we are inclined to think that the employment of a closed circuit for a universal telegraph system possesses great advantages over an open circuit, not the least being the immediate detection of a break in the wire. It also makes the adjustment of the apparatus easier, and less liable to alteration from a gradual weakening of the battery power. The action of the batteries is also rendered more uniform; the consumption of material is no doubt greater, but the increased expense consequent thereon is really but a very small fraction of the general working expenses of any system of the kind. With reference to the liability to interruption on the ordinary single wire call system as now extensively employed in America, we have the assurance of Mr. Andrews, the President of the American District Telegraph Company, that

the percentage of interruptions from two or more stations calling at the same time is but 1 in 10,000. Any continuation of the present correspondence can only appear in the advertisement columns.—Ed. *T. J.*]

Messrs. Edmundson and Co., 19, Great George-street, Westminster, write us that they are the sole London agents for the new system of electro-pneumatic bells, referred to on page 284; and would be glad to show and explain them to any interested.

QUERIES.

1. To what extent are the *Wheatstone automatic instruments* used on the lines in Great Britain, the Continent, or America?

2. Are they used for ordinary commercial telegrams, or only for press reports or after an interruption?

3. Is the instrument likely to supersede the Morse for ordinary commercial telegrams?

4. Why is the instrument not recognised in the St. Petersburg Convention? See Service Reg., No. 3.

5. What is the longest circuit on which these instruments are worked in Great Britain?

6. Is the wire used for transmitting the current for these instruments placed upon separate poles? If not, does not the induction impede the use of the other wires?

7. What is the length of longest circuit ordinarily worked with Morse instruments in Great Britain?

8. From whom are Wheatstone's Automatic Instruments obtainable, and what about is the price per set, including transmitter, receiver, key, perforator, galvanoscope, and bell?

ENOCH ARDEN, Queensland.

What are the dates of M. La Cour and Prof. Reuss's patents, and who is to be considered the real inventor of the Telephone? A. Z.

AN ELECTRIC DISCHARGE IN A TELEGRAPH OFFICE.—On Sunday, October 15, 1876—a sunny, clear, clod day—at Fremont, O., an electric discharge took place from the telegraph wires, where they enter the switch-board in the telegraph office, igniting the covering of the wires, setting fire to the ornamental scrollwork on the switch-board and scorching the wall. Further damage was prevented by the accidental discovery of the fire, no one being in the office at the time of the electric discharge. The wires were cut off from the instruments, and supposed to be efficienfly guarded against a discharge of lightning by a ground wire carried along near the top of the switch-board, in contact with the covering of the wires. While the arrangement described may issue the safety of the instruments, this occurrence shows that it may imperil the building containing them.—*Railway Gazette.*

THE ELECTRIC PEN.—A brief explanation of the action of this instrument, which has excited a good deal of interest, may be useful to some of our readers. The pen consists of a tube about four inches long, at the top of which is affixed a small wheel and an electro-magnet; the whole is connected with a battery by a flexible wire. By means of the alternate breaking and connection of the electric current, the wheel is made to revolve with considerable velocity. On the axis of the wheel is fixed a fine vertical shaft, which is inserted in the tube and ends in a needle. This forms the "Pen." In operation it is held perfectly upright, and passed over the paper to be written upon. Upon connecting the battery the point of the needle is sharply projected from the end of the tube, at the rate, we are told, of 6,000 or 7,000 times per minute. The paper is thus pierced with fine holes, and a paper stencil is formed. From this stencil some thousands of *fac-simile* can be made at the rate of from 200 to 400 per hour. The character of the writing closely resembles the ordinary handwriting of the operator, whilst drawings of great fineness and accuracy may be made by a draughtsman after a little practice. The copies are produced by simply passing an inked roller over the stencil, which is first fixed in a frame. The management of the pen seems easily mastered. The copying is quite simple, and with moderate care the apparatus cannot get seriously out of order. It enables merchants and brokers to issue weekly or daily price lists without the expense and delay of lithography, whilst the privacy it ensures will commend it to bankers, accountants, and private companies. The pen is supplied by the Electric Writing Company, of 9, New Broad-street, London, where it may be seen in action.

PROF. ANTHONY'S ELECTRIC LIGHT EXPERIMENTS.—In the note about these, in last number (p. 297), the lamp used for comparison of light values was incorrectly designated as the one used in the engine. Prof. Anthony gives in the *Scientific American* the following brief description of his experiments:—

"To the electro-magnetic machine, which was driven by a Brayton petroleum oil-engine of five-horse power, wires were connected for conveying the electricity produced to a room some 300 feet distant, from which daylight could be excluded, for photometric experiments. In this room, the wires were connected with a Foucault regulator for the electric light, the light being produced by the passage of the electric curve between two carbon points. The electric light being too brilliant for direct comparison with the standard candle, I took from my house a common coal oil lamp, having a flat wick one inch wide. The electric light was found to be equal to what would have been produced by 234 such lamps. But 234 such lamps would have consumed nearly 16 lbs. oil per hour, while the engine, whose power developed the electric current, which in turn produced the electric light, consumed but 6¾ lbs. oil in the same time. This fact was stated in the paper giving the results of my experiments merely as showing, in a striking manner, how very small a proportion of the energy of combustion of the oil in the common lamp is utilized as light."